Nuclear Science Division Newsletter

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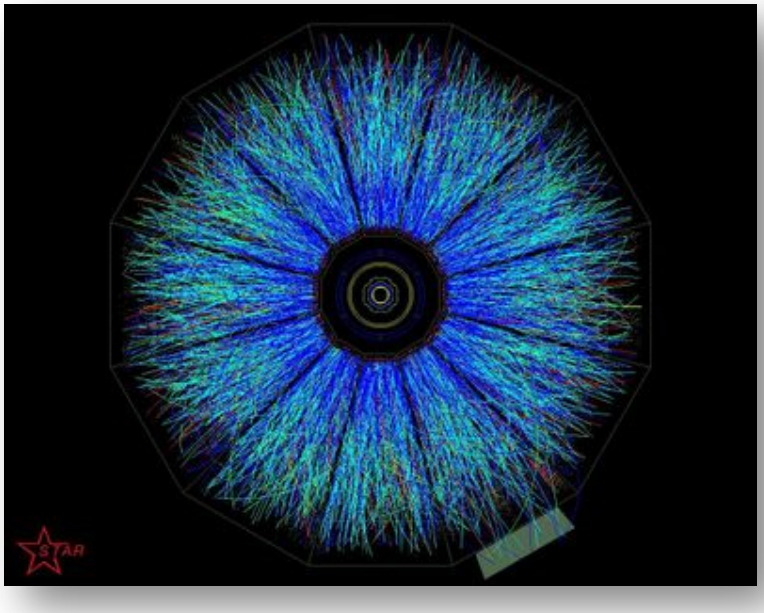
NSD hosts Summer Students

Summer at the Berkeley lab means we can expect a new crop of student internships; this year is no exception. This year, NSD is hosting twelve summer students, plus two faculty advisors, to work on a variety of projects. For the 3rd year in a row, Southern Arkansas University Professor Abdel Bachri has taken advantage of the DOE FAST (Faculty and Student Teams) to bring a crew of four undergraduates to LBNL to work with Azriel Goldschmidt on technology for double beta decay searches in a high pressure xenon time projection chamber. Prof. Edmundo Garcia-Solis brought two undergraduates from Chicago State University to work with Peter Jacobs on ALICE. Their funding, from an NSF fund to encourage minority participation in science, will allow them to spend several weeks at CERN. Both Southern Arkansas and Chicago state are minority serving institutions. In addition, Alan Poon and James Loach are hosting three students to work on MAJORANA, Peter Jacobs is hosting an additional student on ALICE, and Howard Matis has a student working on LHC luminosity measurement with the Lumi detector.

Azriel Goldschmidt (left) with the Southern Arkansas group. Professor Abdel Bachri is to the right.

LBNL Does Quark Matter

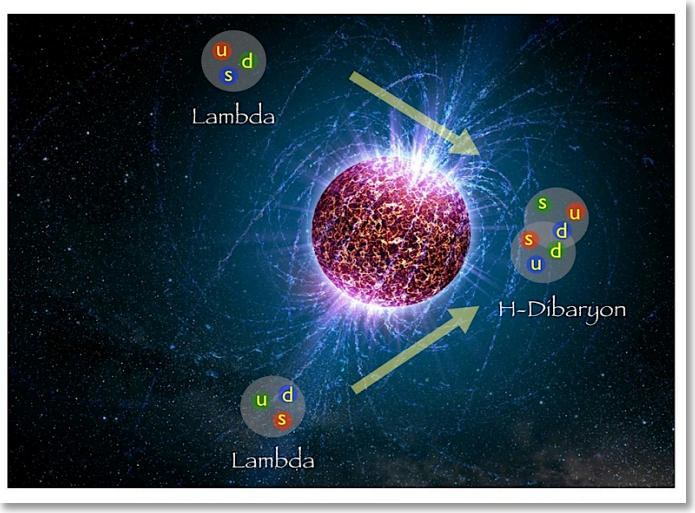
LBNL was well represented at the 2011 Quark Matter Conference in Annecy, France. QM is the premier gathering in the field of heavy-ion physics. The LHC was the new kid in town, but it was clear that RHIC still has much to offer. LBNL's Hiroshi Masui was selected to present a plenary talk giving an overview of recent STAR results. Hiroshi began with an overview of new results on jets and heavy flavors, then moved on to electromagnetic and bulk probes, and then concluded with a discussion of the on-going beam energy scan. Other highlights in his talk included the observation of anti-helium-4, new results on triangular flow (v_3), observation of J/ψ photoproduction, and results on particle ratio fluctuations, net protons and elliptic flow from the recent low-energy running (at energies of 7.7, 11.5, 19.6 and 39.6 GeV). In the parallel sessions, Alex Schmah (elliptic flow at low beam energies), Yifei Zhang (open charm cross-section and it's suppression in heavy-ion collisions) and Jie Zhao (dileptons) provided additional details on their work. Zhao's work on dileptons extends STAR's physics reach into a new area. Of course, the LHC was not neglected; Constantine Loizides spoke on the ALICE multiplicity results (he is the lead author on the paper on this subject) and Peter Jacobs led a discussion on the jet session.



On the theory side, Giovanni Chrilli discussed next-to-leading order structure functions for use in deep–inelastic scattering in large nuclei using a color dipole formalism, and Xin-Nian Wang discussed the suppression of high transverse momentum hadrons at the LHC. Volker Koch led a plenary discussion on fluctuations and correlations in heavy ion collisions; these are expected to be clear signatures of the tri-critical point that is the target of the current RHIC energy scan.

Supercomputers Bind nuclei Together

Although the equations of Quantum Chromodynamics (QCD) are well known, applying them to everyday low-energy interactions of quarks and gluons is difficult; the quark-gluon coupling is large so the technique of perturbation theory breaks down. Understanding how quarks and gluons behave when bound into protons, neutrons and nuclei requires the use powerful supercomputers to approximate spacetime on a discrete lattice (a technique known as Lattice QCD). Even with these computational methods, understanding the formation of nuclei from QCD, the fundamental theory of strong interactions, remains a challenge. Progress has depended both on steadily increasing processor speeds and on improved algorithms.



Two groups have recently made significant progress in the study of nuclei from QCD, reporting the first Lattice QCD calculations demonstrating the existence of a bound two-baryon system. The NPLQCD and HALQCD Collaborations calculated the binding energy of a system with strangeness = -2 and isospin = 0, the quantum numbers of the H-dibaryon, first postulated by Robert Jaffe in 1977. Jaffe's proposal spawned a flurry of experimental work to detect the H, and, although no H-dibaryon has been seen, a definitive experiment has yet to be done. Dibaryons may form in the interiors of neutron stars, and play a role in their stability and their possible collapse to a black hole or other exotic form of matter. This work is highlighted in Physical Review Letters, http://physics.aps.org/synopsis-for/10.1103/PhysRevLett.106.162001. Due to computational restrictions, these calculations were performed with quark masses heavier than those of nature. Further calculations are being performed to check if the H-dibaryon remains a bound state at the physical values of the quark masses.

With the strong computational resources available at the national energy research supercomputer center (NERSC), LBNL is a natural home for lattice gauge QCD; NSD/UC Berkeley's Wick Haxton is building a group to take advantage of these resources. His postdoc André Walker-Loud is a member of the NPLQCD Collaboration and a significant portion of NPLQCD computations are performed at NERSC. More information about NPLQCD is available at:
http://www.phys.washington.edu/users/savage/NPLQCD/NPLQCD--2008.htm

IceCube Opens for Business

On April 26-May 2nd, the IceCube collaboration celebrated the completion of construction. The week-long gala included a collaboration meeting, a conference "IceCube Invites Particle Astrophysics, and a symposium on Antarctic Science. A session on the history of IceCube included Dave Nygren who reviewed LBNL's seminal contributions to IceCube, most notably the Digital Optical Module and its early incarnation in AMANDA string 18. After the IceCube "Winter Overs" opened the formal inauguration via video from the South Pole, a host of dignitaries, including Congressman Dave Obey (ret.), NSF Director Subra Suresh, representatives from European funding agencies officially started the running.

The on-ice Ice Cubers celebrate the completion of construction in December 2010.

LBNL played key roles in the meetings. Graduate student Sandy Miarecki gave a well-received plenary talk on her improved method for muon energy measurement; this will be a key part of her thesis, a measurement of the neutrino-nucleon cross-section at energies around 50 TeV. Joanna Kiryluk and Spencer Klein organized sessions on 'cascades' and on diffuse neutrinos respectively, while Lisa Gerhardt presented her analysis on high p_T muon in cosmic-ray air showers.

The meeting also looked forward to future experimental efforts in Antartica, including radio-detection. There was much excitement about a future add-on infill array for IceCube which would densely instrument a mega-ton volume, allowing for nearly background-free detection of supernova neutrinos out to mega-parsec distances (enough to detect ~1 supernova/year), and for proton decay searches. More information on the meeting is available at http://icecube.wisc.edu/Apr2011/inauguration .php.